Electric Field and Plasma Dynamics in the Inner Magnetosphere and Plasmasphere during a Geomagnetic Storm

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Variations of cold plasma density distribution and large-scale electric field in the inner magnetosphere and plasmasphere during a geomagnetic storm were investigated by using the observation data of the Akebono satellite which has been carried out for more than 15 yeas since March, 1989. We focus on the super geomagnetic storm on March 13-15, 1989, for which the maximum negative excursion of the Dst index was -589 nT. The distribution of the electric field intensity in the plasmasphere region of $L<5.1$ before the onset of the geomagnetic storm shows almost a spatial homogeneity with a small value of less than 0.3 mV/m. Its distribution indicates a typical signature of the dawn-to-dusk electric field inside the plasmasphere during a magnetically quiet condition. This evidence implies that the plasmaspheric plasma moves with a co-rotation lag from the earth's rotation. It is noted that the electric field intensity is a little enhanced within an L-value range of L=5.0-5.3 with the maximum intensity of about 0.3 mV/m at L=5.2. During the main phase of the magnetic storm, a strong electric field with a spatially inhomogeneous structure appears in the inner magnetosphere between L=2.0 and 7.0. The averaged intensity of the electric field was in a range of about 2.5-9.2 mV/m. The spatial distribution in the magnetic equatorial region indicates that the magnitude within an L-value range of 2.2-7.0 is much larger than that observed at L=7.0-10.0. Associated with the appearance of the strong electric field, the cold plasma density near the trough region around L=3.0-6.0 was enhanced with one or two order magnitude, compared with that in the magnetically quiet condition. This implies that a mount of the ionospheric plasma may be supplied from the topside ionosphere into the trough and plasmasphere regions by the frictional heating due to the fast plasma convection in the ionosphere as pointed out by previous studies on the enhancements of plasma density in these regions, based on incoherent scatter radar and total electron content (TEC) observations [e. g., Yeh and Foster, 1990; Foster et al., 2004]. During the recovery phase of the magnetic storm, the convection electric field observed in the inner magnetosphere and plasmasphere regions recovers within 3-4 days almost up to the level of the magnetically quiet condition.